

What is claimed is:

1 1. A method of transmitting data over a communica-
2 tions network, comprising the steps of:

3 multicasting content in a first transmission over a
4 data network from a sender to a multicast group compris-
5 ing a plurality of receivers;

6 in each of said receivers concurrently performing
7 the steps of:

8 detecting a missing portion of said content;

9 and

10 responsive to said step of detecting, delaying
11 for a random interval ;

12 thereafter transmitting no more than one negative
13 acknowledgement in a second transmission from one of said
14 receivers to said sender; and

15 responsive to said negative acknowledgement multi-
16 casting said missing portion in a third transmission from
17 one of said sender and another of said receivers to said
18 multicast group.

1 2. The method according to claim 1, wherein said ran-
2 dom interval has a lower limit given by

$$LL = (a_1 t_{min}) \times b$$

3 wherein \times is a multiplication operator, a_1 is a propor-
4 tionality constant, t_{min} is a minimal round trip transmis-
5 sion time between said sender and a respective one of
6

7 said receivers, and b is a size of a largest packet of
8 said missing portion.

1 3. The method according to claim 1, wherein said ran-
2 dom interval has an upper limit given by

3
$$UL = (a_1 t_{\min}) \times b$$

4 wherein x is a multiplication operator, a_2 is a propor-
5 tionality constant, t_{\max} is a maximum round trip transmis-
6 sion time between said sender and a respective one of
7 said receivers, and b is a size of a largest packet of
8 said missing portion.

1 4. The method according to claim 1, further compris-
2 ing the step of

3 determining a current quantity of traffic on said
4 data network;

5 wherein said second transmission is sent when said
6 current quantity is less than a predetermined value.

1 5. The method according to claim 1, wherein said ran-
2 dom interval is a shortest said random interval of said
3 receivers.

1 6. The method according to claim 1, wherein said
2 third transmission is sent by said sender.

1 7. The method according to claim 1, wherein said
2 third transmission is sent by one of said receivers.

1 8. A computer software product, comprising a com-
2 puter-readable medium in which computer program instruc-
3 tions are stored, which instructions, when read by at
4 least one computer, cause said at least one computer to
5 execute a method of transmitting data over a data net-
6 work, comprising the steps of:

7 multicasting content in a first transmission over
8 said data network from a sender to a multicast group com-
9 prising a plurality of receivers;

10 in each of said receivers concurrently performing
11 the steps of:

12 detecting a missing portion of said content;

13 determining a random interval; and

14 responsive to said step of detecting, delaying
15 for said random interval ;

16 thereafter transmitting no more than one negative
17 acknowledgement in a second transmission from one of said
18 receivers to said sender; and

19 responsive to said negative acknowledgement multi-
20 casting said missing portion in a third transmission from
21 one of said sender and another of said receivers to said
22 multicast group.

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9. The computer software product according to claim 8, wherein said random interval has a lower limit given by

$$LL = (a_1 t_{\min}) \times b$$

wherein x is a multiplication operator, a_1 is a proportionality constant, t_{\min} is a minimal round trip transmission time between said sender and a respective one of said receivers, and b is a size of a largest packet of said missing portion.

10. The computer software product according to claim 8, wherein said random interval has an upper limit given by

$$UL = (a_1 t_{\min}) \times b$$

wherein x is a multiplication operator, a_2 is a proportionality constant, t_{\max} is a maximum round trip transmission time between said sender and a respective one of said receivers, and b is a size of a largest packet of said missing portion.

11. The computer software product according to claim 8, further comprising the step of

determining a current quantity of traffic on said data network;

wherein said second transmission is sent when said current quantity is less than a predetermined value.

1 12. The computer software product according to
2 claim 8, wherein said random interval is a shortest said
3 random interval of said receivers.

1 13. The computer software product according to
2 claim 8, wherein said third transmission is sent by said
3 sender.

1 14. The computer software product according to
2 claim 8, wherein said third transmission is sent by one
3 of said receivers.

1 15. A computer system, comprising:
2 a first computer;
3 a second computer interconnected in a data network
4 with said first computer, said first computer and said
5 second computer receiving multicast content in a first
6 transmission via said data network from a content server;
7 wherein said first computer and said second computer
8 have program instructions stored therein, which instruc-
9 tions cause said first computer and said second computer
10 to concurrently execute a method of transmitting data
11 over a communications network, comprising the steps of:
12 detecting a missing portion of said content;
13 determining random intervals, wherein a first random
14 interval of said first computer is shorter than a second
15 random interval of said second computer; and

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responsive to said step of detecting, said first computer delaying for said first random interval, and said second computer delaying for said second random interval; and

thereafter said first computer transmitting a first negative acknowledgement in a second transmission to said content server;

said content server resending said first negative acknowledgement to said second computer, wherein in an event that said second computer has not received said missing portion, said second computer suppresses a second negative acknowledgement therefor; and

receiving said missing portion in a third transmission from said content server.

16. The computer system according to claim 15, wherein said random intervals each have a lower limit given by

$$LL = (a_1 t_{\min}) \times b$$

wherein \times is a multiplication operator, a_1 is a proportionality constant, t_{\min} is a minimal round trip transmission time between said content server and a respective one of said first computer and said second computer, and b is a size of a largest packet of said missing portion.

1 17. The computer system according to claim 15,
2 wherein said random intervals each have an upper limit
3 given by

$$UL = (a_1 t_{\min}) \times b$$

4
5 wherein x is a multiplication operator, a_2 is a propor-
6 tionality constant, t_{\max} is a maximum round trip transmis-
7 sion time between said content server and a respective
8 one of said first computer and said second computer, and
9 b is a size of a largest packet of said missing portion.

1 18. The computer system according to claim 15,
2 wherein said first computer further performs the step of
3 determining a current quantity of traffic on said
4 data network;

5 wherein said second transmission is sent when said
6 current quantity is less than a predetermined value.

1 19. The computer system according to claim 15,
2 wherein said third transmission is sent by said content
3 server.

1 20. The computer system according to claim 15,
2 wherein said third transmission is sent by said second
3 computer.